Time is of the Essence

Electrical Systems and Geothermal Development in the Central American Isthmus

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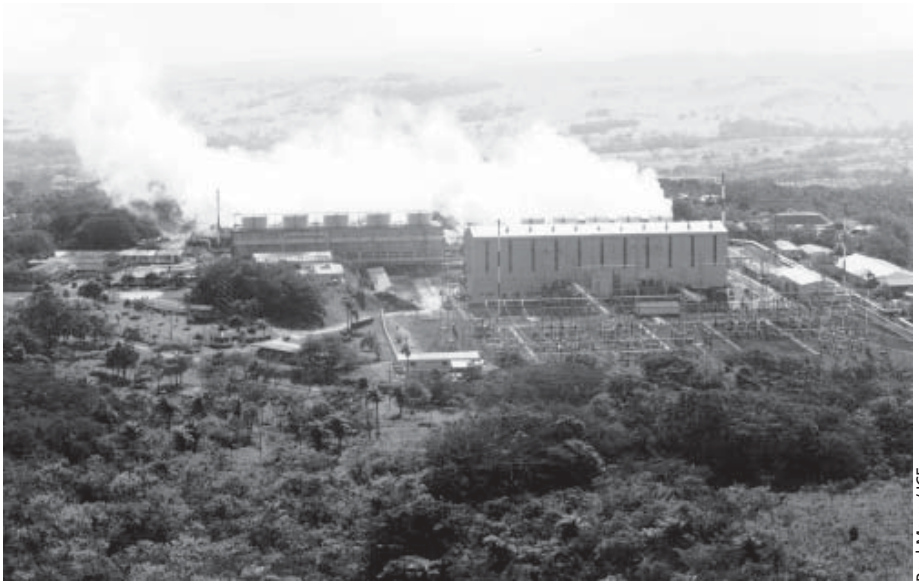

Paul Moya / ICE

Units 1 and 2, and substation for Units 1, 2 and 3 at the Miravalles Geothermal Field, Costa Rica.

Significant reforms in the Central American electricity market have recently taken place and others are imminent. The following article will briefly review the electrical system of the Central American Isthmus, its current status and future, and the possible impact that planned projects might have on geothermal developments in the region. The "Isthmus" refers to the countries of Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica and Panama.

Because of its particular geologic framework—several tectonic plates interact in the region (Fig. 1)—the Isthmus is blessed with abundant geothermal resources with a power production capacity estimated at between 2,000 and 16,000 megawatts (MW) (Lippmann, 2002). Most relevant is the fast subduction of the Cocos Plate under the Caribbean Plate, which results in uplift, active volcanism, and frequent, strong earthquake activity throughout much of Central America.

At present, most geothermal development activities in the region are focused on sustaining production at existing power plants (i.e., maintenance and repair of power plants, surface installations and wells, and drilling of development and replacement wells). Exploration for geothermal resources in Central America has slowed significantly in the last 5 to 7 years because:

- Governments are giving investment priority to other sectors of their economies.
- Oil prices have been low, mostly in the $10 to $20 (US) per barrel range during the last decade.
- Privatization of parts of the electrical sector has occurred in some countries. However, the private sector prefers to invest in more "traditional," less risky generation schemes such as hydropower and fossil-fueled power plants in deregulated electrical markets.

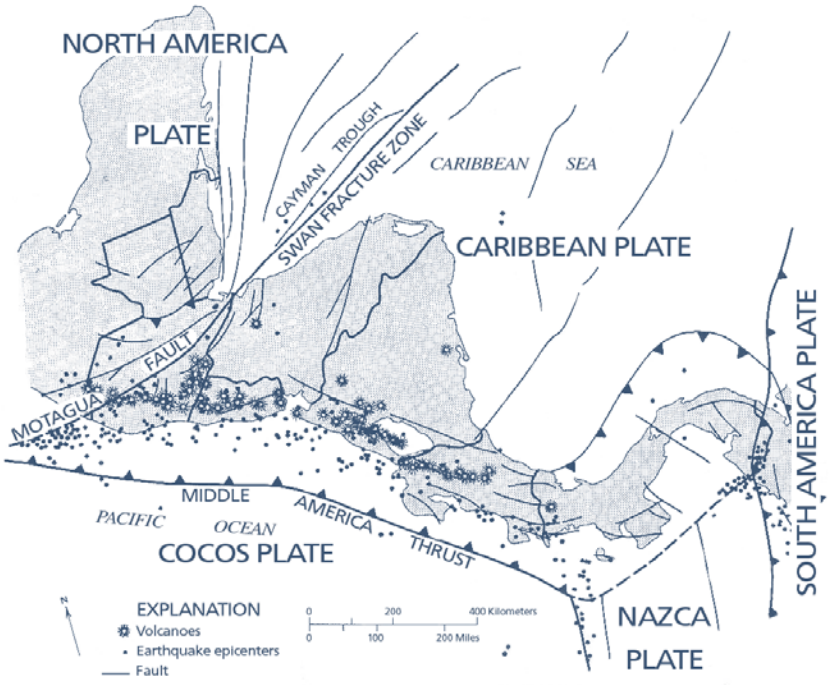

Figure 1. Simplified tectonic map of Central America (from Cunningham et al., 1984).

- Geothermal projects have had difficulty in obtaining long-term loans. Banks and private investors have become less willing to take the risks associated with exploration and development of geothermal areas.
- There has been less support for geothermal exploration by local governments and international agencies.

Since the first Central American geothermal power plant was built in 1975—a 30-MW flash unit at Ahuachapán, El Salvador—total installed geothermal electrical capacity in the region has grown to more than 400 MW (Table 1). The most recent addition is Unit 3 at Miravalles in Costa Rica, a 27.5-MW flash plant that began generating electricity in March 2000 (Moya and Mainieri, 2002).

Even though the Isthmus saw no new geothermal power plants installed in 2001, generation of geothermal electricity grew a healthy 11.8 percent during that year, mainly because of improved field management practices. This point is clearly illustrated by data provided in Table 1. For more information on recent and near-future geothermal activities in Central America, refer to Lippmann (2002).

Recent Electricity System Developments

Privatization of the region's electricity market is ongoing, but far from complete. Honduras and Costa Rica are the least advanced Central American countries in this respect. Total population of the six countries of the Isthmus was estimated at about 37 million in 2001 (EIA, 2002). The region is one of the poorest in the world, but the situation is improving. Though only 41 percent of the population had access to electricity in 1980, this figure grew to 69 percent in 2000 (Montesino, 2002). The average annual increase in gross national product (GNP) across the region has been about 7 percent.

As population, GNP, and level of electrification continue to grow in Central America, an increase in electricity demand is expected. Montesino (2002) shows that installed electrical-generating capacity in the region has increased from approximately 2,400 MW in 1980 to about 7,100 MW in 2000. At the same time, maximum (peak) demand has grown from 1,584 MW to 4,772 MW during the same period (Fig. 2 provides data for 2000). The large difference between total installed capacity and peak demand is a result of the need to complement the region's large hydroelectric projects with fossil-fueled power plants, to cover electricity demand during dry years, and other eventualities. It is estimated that 1998-2008 annual average power demand growth across the Isthmus will be 6 percent (EIA, 2001). Considering the region's vast resources, geothermal energy could contribute significantly to satisfying increased electricity demands in the future.

Presently, most installed electrical generating capacity on the Isthmus relies on hydroelectric dams and power plants that burn fossil fuels (thermal power plants), with a varying mix among the Central American countries. According to Montesino (2002), the composition of installed capacity across the Isthmus changed significantly between 1990 and 2000. During that period, hydro decreased from 66 to 46 percent, thermal increased from 30 to 48 percent, and renewables (mainly geothermal) increased from 4 to 6 percent. In 2000, installed capacity of all renewable energies (excluding hydro) was below 15 percent in every country of the region, except Panama and Honduras where it was essentially zero (Fig. 3).

Despite these low numbers for renewables, the high-capacity factors typical of geothermal power plants (i.e., an average facility is available 90 percent of the time - DOE, 2002) have resulted in a significantly larger percentage of geothermal electricity generation on the Isthmus relative to installed geothermal capacity. In the case of El Salvador, for example, geothermal claimed 14.3 percent of installed capacity at the end of 2001 (Table 1), but supplied 23 percent of the country's electricity demand in December 2002 (*La Prensa Gráfica*, Jan. 14, 2003). The case was similar in Costa Rica (Moya and Mainieri, 2002). Total gigawatt-hours (GWh) generated by Central American countries are provided in Table 1 and Figure 4.

Until August 2002, the electrical systems of El Salvador and Honduras were not interconnected. Power could only be traded be-

Table 1. Electricity and Geothermal in the Central American Isthmus (2000-2001)[1]

Country	Total Installed Electric Capacity (MW)	Total Installed Geothermal Capacity (MW)	Total Geothermal Electricity Generated (in GWh-net)		Increase 2000-2001	
	End of 2001	End of 2001	2000	2001	GWh-net	Percent
Costa Rica	1707	142.5	980	986	6 [(2)]	0.6[(2)]
El Salvador	1118	160	739	907	168	22.7
Guatemala	1517	33	202	202	-	-
Honduras	882	-	-	-	-	-
Nicaragua	643	70	121	188	67	55.4
Panama	1065	-	-	-	-	-
TOTALS	6932 MW	405.5 MW	2042 GWh	2283 GWh	241 GWh	11.8 %

Notes:
1) Based on recent personal communications from G. Castillo, A. Mainieri, J.C. Palma, E. Reyes, J.A. Rodríguez and A. Zúñiga.
2) The two 55-MW power plants at Miravalles were overhauled in 2001, and out of service for two months.

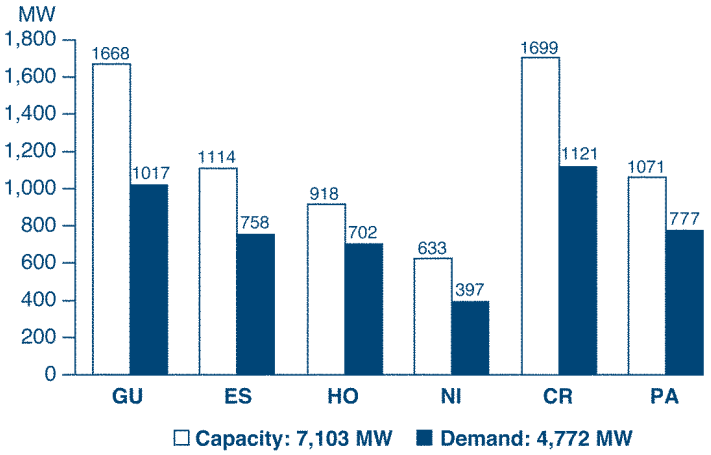

Figure 2. Central American Isthmus electricity system. Installed capacity and maximum demand by country in 2000. GU: Guatemala; ES: El Salvador; HO: Honduras, NI: Nicaragua; CR: Costa Rica; PA: Panama. Figures 2, 3, 4 and 5 are based on CAPAL/ECLAC data, as modified from Montesino (2003).

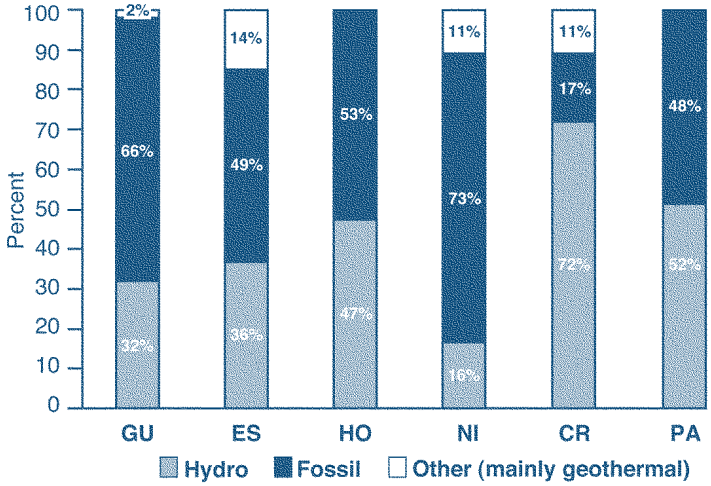

Figure 3. Central American Isthmus electricity system. Installed capacity by energy source and country in 2000.

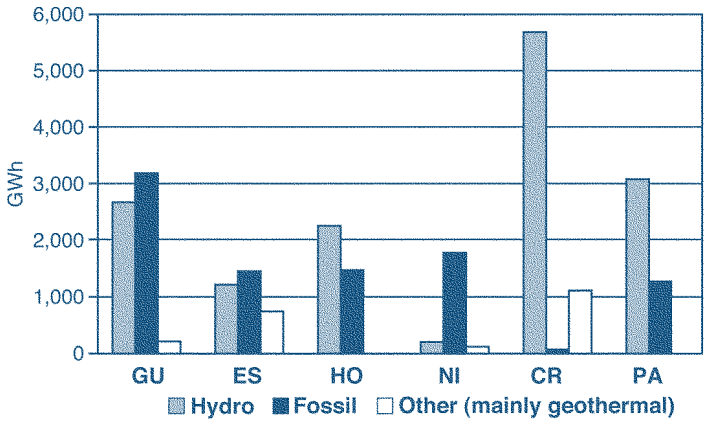

Figure 4. Central American Isthmus electricity system. Net generated electricity by energy source and country in 2000.

tween Guatemala and El Salvador in the north; and among Honduras, Nicaragua, Costa Rica and Panama in the south. In spite of this, however, the amount of electricity traded across borders in Central America has grown significantly over the years. In 1980, only 30 GWh of electricity were traded, but by 2000 trading reached about 1,470 GWh (Montesino, 2002 – Fig. 5).

The situation will further improve now that the Salvadoran and Honduran grids are linked by a 230-kilovolt line with a maximum capacity of 100 MW. The official inauguration of this project was held on Aug. 21, 2002. Since then, it has been possible to transmit electricity from one end of the Isthmus to the other. Trades between countries have already been accomplished with the new line (J.A. Rodríguez, personal communication, 2002).

Within a few years, a number of projects will significantly change the Central American electrical system. The "SIEPAC Line" (Fig. 6), for example, will allow the transfer of up to 300 MW of electric power among the countries of the Isthmus after its scheduled completion in 2006. This power transmission line is part of the "Sistema de Interconexión Eléctrica Países América Central" (SIEPAC) project. According to De la Torre (2002), the SIEPAC project will not only build the first regional electrical transmission system on the Isthmus, but create a Central American wholesale electricity market, the "Mercado Eléctrico Regional" (MER). The market will function under the guidance of two regional organizations, the "Comisión de Interconexión Eléctrica Regional (CRIE) and the "Ente Operador Regional" (EOR). CRIE will regulate the market, while EOR will operate the system.

Discussions continue on construction of another transmission line that would tie together the electrical grids of Guatemala and southern Mexico. This project could begin as early as this year (2003). In addition, a natural gas pipeline from Ciudad Pemex (southern Mexico) to Escuintla (southern Guatemala) is expected to be completed in 2004. The 558-km (347-mile) line will transport gas for industrial use and electricity generation. Initial demand is estimated at about 1 million cubic meters (40 million cubic feet) of natural gas per day. The pipeline could eventually be

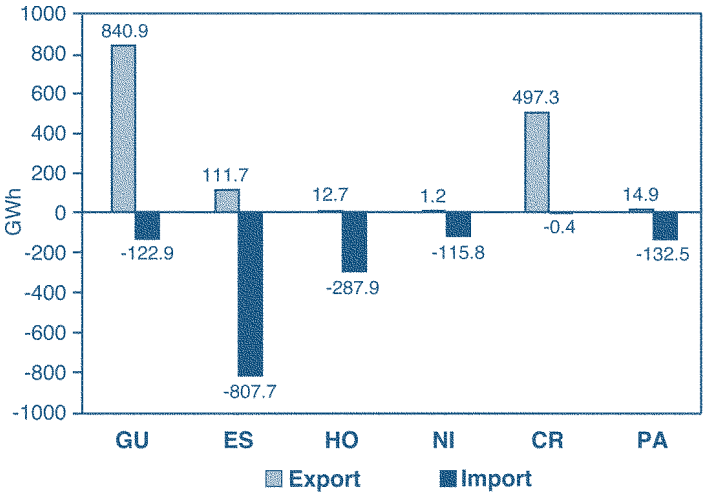

Figure 5. Central American Isthmus electricity system. Amounts of electricity traded by country in 2000.

extended to the Honduran and Salvadoran borders, and possibly to Nicaragua and Costa Rica as part of a wider Central America gas pipeline network (EIA, 2002).

These developments are expected to enable continued investment in fossil-fueled power plants, including larger ones with capacities of a few hundred megawatts or more. A number of companies, mainly from the United States, have begun to expand the capacity of existing power plants and/or build new facilities in the region. Unfortunately, all will burn some type of fossil fuel.

The largest of the new projects is a 780-MW natural gas-fired, combined-cycle plant that AES Corp. is planning to build in Puerto Cortes on the Caribbean coast of Honduras (AES, 2002). Liquid natural gas will be shipped to the site. The construction of special facilities to handle the imported gas will be required, and a 373-km (232-mile) transmission line must be built to link the plant with the regional electrical grid. These fossil-fuel developments are proceeding despite the high cost of generating electricity in thermal power plants. Articles in Honduran newspapers during 2002 noted costs of approximately 10¢ (US) per kilowatt-hour.

Energy Project Impacts on Geothermal Opportunities

As indicated earlier in this article, geothermal development activities in Central America have slowed down during the last few years, even though the region is blessed with vast resources of this environmentally benign, indigenous energy alternative.

Construction of new electrical transmission lines, natural gas pipelines and large thermal power plants may further impact future development of Central American geothermal resources. Yet even though huge investments in hydroelectric dams, thermal power plants and related infrastructure are being made, it is not clear what will occur as the price of fossil fuels keeps increasing (oil prices reached nearly $40 [US] per barrel by the end of February 2003). This is an inevitable development as world oil reserves become smaller, demand increases, and world political events threaten supplies (Meidav, 2001). The overall rising price trend and volatility of crude oil and natural gas spot prices is clearly illustrated by Figure 7.

In any case, it is difficult to imagine that the Central American countries and private-sector companies would abandon their investments. In other words, higher oil and natural gas prices would

Country	Length (in km)
Guatemala	281.8
El Salvador	282.3
Honduras	369.4
Nicaragua	293.5
Costa Rica	462.4
Panama	140.3
Total	1,829.7

Figure 6. SIEPAC Line. First regional electricity grid for Central America (modified from De la Torre, 2002).

simply result in higher electricity prices to consumers—an unacceptable situation from both economic and political points of view.

Besides fossil-fueled power plants, the other major source of electricity in the Isthmus is hydropower. Rainfall determines how much power can be generated by hydroelectric projects. The region is characterized by periods of droughts and heavy rains. Furthermore, climatic conditions vary not only from year to year, but from country to country. In June 2002, prevailing drought conditions resulted in low water levels behind many dams in the region. Thus, the amount of electricity generated by thermal (oil-burning) power plants was larger than usual, resulting in higher electricity bills to consumers.

It was thought that this situation might worsen, depending on how the current El Niño climatic phenomenon affects the Isthmus. Even though heavy precipitation occurred late in the rainy season—from May to October—water levels behind dams in Central America did not fully recover. Higher than normal amounts of thermal-electricity generation are expected to continue until the beginning of the 2003 rainy season. These events illustrate the uncertainties associated with both national and regional electrical systems that rely heavily on hydropower projects.

In summary, increased fossil-fuel costs and drought conditions would mean more expensive electricity throughout the Isthmus. If this occurs, Central American countries will suffer in terms of their ability to compete in world markets, and governments will be criticized by all sectors of society. Subsidizing the price of electricity is a possible, but expensive, solution that most of the region's countries cannot afford.

Despite the potential pitfalls of increased reliance on fossil fuels and hydropower, private-sector developers may be reluctant to invest in Central American geothermal projects—typically in the 10- to 50-MW range—in a market dominated by large thermal power plants and hydroelectric dams. Considering the 3- to 5-year lead time needed to start generating income from a geothermal project, developers may require concrete evidence from local governments and/or multinational agencies of long-term support for renewable energy projects. However, such support can only be accomplished with laws and policies like tax incentives, renewable energy portfolio standards, and carbon credits.

Recommendations

It is not too late for trade associations and other groups that support geothermal resource development to approach Central American governments to: 1) emphasize the advantages of developing geothermal resources in the region; 2) stress immediate environmental and foreign exchange problems (as well as climatic uncertainties and rising costs associated with large thermal power plants and hydroelectric projects); and 3) urge passage of legislation that will provide financial and other incentives for projects that use indigenous, renewable energy sources like geothermal. In addition, meetings should be set up with officials of U.S. and multinational agencies to request development grants and the creation of loan guarantees, carbon credit programs, and other vehicles to facilitate exploration and development of new geothermal areas in Central America (and elsewhere around the world).

Central American governments should be reminded that most geothermal projects in the region are being delayed because of a lack of clear policies on renewable energy resources and their development for electricity production. Such policies could include tax incentives and/or subsidies for developing indigenous renew-

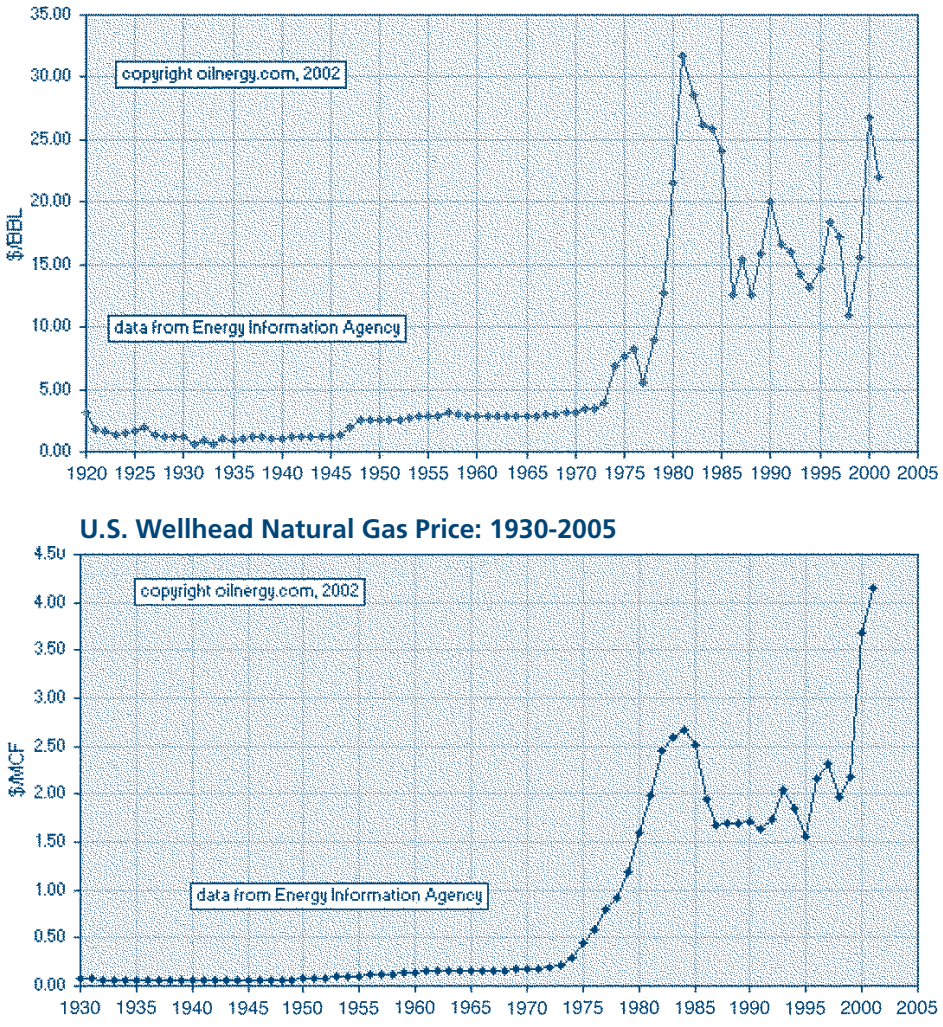

Figure 7. History of U.S. crude oil and natural gas prices, in U.S. dollars per barrel and thousand cubic feet (data from www.oilnergy.com; published with permission).

able energy sources and the implementation of an active carbon credit market. The need for long-term power purchase agreements that allow geothermal developers to acquire funding for large, up-front project investments should also be stressed. In the absence of such agreements, subsidies for exploration would be a viable option to increase geothermal development.

In conclusion, expected changes in the Central American electricity system do not favor renewable energy alternatives. This is especially true for geothermal resources. It is imperative to educate Central American leaders about the pitfalls of over-reliance on fossil fuels and hydropower projects to meet rising regional power demand. Central American governments should encourage the development of policies and incentives that foster energy diversification and the long-term energy stability that it brings. Solutions to these issues would place renewables in a more favorable competitive position, and since one of the largest sources of renewable power in the region is geothermal, would especially favor its development. But with decisions currently being made about the construction of new fossil-fueled power and hydroelectric plants (and related infrastructure) across the Isthmus, it will become increasingly difficult to rally the support of Central American governments and multinational agencies for new geothermal projects. Time is of the essence.

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